DOCUMENT RESUME

ED 177 876 FL 010 586

AUTHOR Mulford, Randa
TITLE Prototypicality and the Development of Categorization. Papers and Reports on Child Language Development, No. 16.
INSTITUTION Stanford Univ., Calif. Dept. of Linguistics.
PUB DATE Apr 79
NOTE 14p.
AVAILABLE FROM PRCLD, Department of Linguistics, Stanford University, Stanford, CA 94305

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Association (Psychological); Child Development; *Child Language; *Classification; *Cognitive Development; Kindergarten Children; *Language Development; Language Processing; Language Research; Preschool Children; Psycholinguistics

ABSTRACT

Children aged three to five were the subjects of two studies of the development of ability to classify diverse objects into superordinate categories. In the first experiment, subjects were asked to designate two of three pictorially represented objects as representative of a given category. The second experiment required subjects to choose from a random array of objects those which fell within a given category. Results tend to support these hypotheses: (1) younger children recognize as category members a greater percentage of highly prototypical members than less prototypical members, (2) with increasing subject age, there is a decrease in the difference of percentages of high-prototypicality and low-prototypicality members correctly identified, and (3) the absolute percentage of correct identifications of category members increases with age for both high and low instances. (JB)

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PRCLD #16
(1979)

PROTOTYPICALITY AND THE DEVELOPMENT OF CATEGORIZATION*

Randa Mulford
Department of Linguistics
Stanford University

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Recently, some very provocative proposals about the organization of semantic categories in human cognitive processing, including language use, have been emerging in the writings of Eleanor Rosch and her associates at U.C. Berkeley. In a series of ingenious, converging experiments, these psychologists seem to have found evidence for principles that structure our knowledge in interactions involving the world around us.

Rosch's original work showed that perceptual categories like colors and simple geometric forms seem to be organized around a "focus" or "prototype" which is easier to learn to recognize and to remember than other less central members of the same category. For example, "true" red or a perfect circle is somehow easier to store and to identify or match in a different context than a particular shade of burgundy or a particular oval shape. This she found to be true not only for American adults, but also for American preschoolers and for members of a Stone Age culture, the Dani people of New Guinea. She proposed that people were somehow "defining" color or shape categories in her experimental tasks as variations on these focal examples, which, it might be claimed, are "givens" of the human perceptual system.

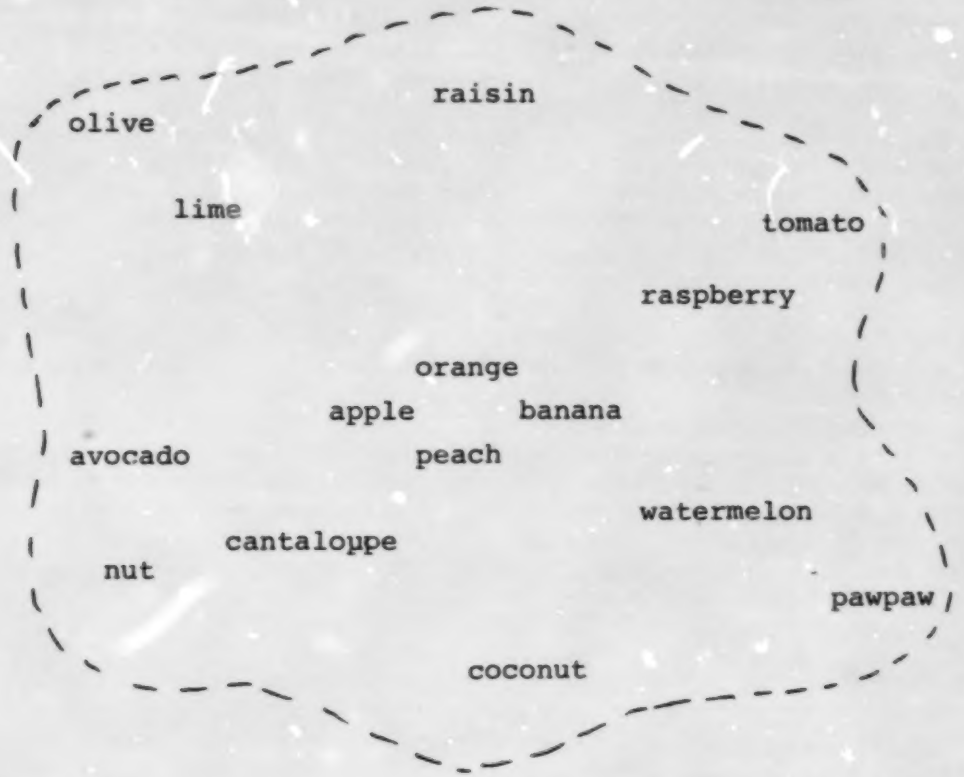
In subsequent research, she has extended her investigation to cognitive categories less specifically tied to visual perception, both biological categories, such as fruit and animals, and artifactual ones, such as furniture and clothing. Working with large numbers of college student subjects and an array of experimental paradigms, she again found consistent behavioral evidence that these categories also appear to be learned and processed with reference to some central member or members, although in this case the prototype is much less likely to have any primacy in the human perceptual system.

On the basis of her empirical results, Rosch has made some specific proposals about the nature of categories of objects found in the real world. In her view, most "real" categories are highly structured internally but do not have well-defined boundaries. They are composed of a core which consists of the clearest cases, "best examples", or, as Rosch refers to them, "prototypes" of the category, surrounded by other category members of decreasing similarity to the core. Thus items within categories may be considered differentially representative of the category label. The more prototypical of a category a member is rated, the more attributes it has in common with other members of contrasting categories. These attributes are typically characteristic of the category but are not necessarily true of all its members. There may be no common attribute for the category as a whole. Prototypes are those category members

which most reflect the redundancy structure of the entire category, i.e., that are characterized by the greatest number of attributes held in common. Candidates for membership in a category usually cannot be included or excluded solely on the basis or one or more criterial features, but are evaluated in terms of the overlap of their attributes with the cluster of attributes associated with the prototype(s).

In Figure I, I have tried to give a more concrete illustration of Rosch's proposals about category structure. Here we have a rough schematization of the cognitive organization of some members of the superordinate category fruit, which was one of

FIGURE I
Example of Category-internal Structure



Attributes associated with the category fruit:

sweet taste
spherical shape
tree-grown
can be eaten cooked or raw
has a colorful peel
has inedible seeds or pit

the categories for which Rosch collected prototypicality ratings. Within this category we have some very good or highly prototypical members like apple, orange and peach, which can be represented as conjunctions of a large number of attrubutes commonly associated with fruit, such as sweet taste, spherical shape, tree-grown, can be eaten cooked or raw, has a colorful peel and inedible seeds or pit. There are also, a little farther from the center, some category members of "medium" goodness or prototypicality, correctly assigned fewer of these characteristics, but fruit nonetheless, such as cantaloupe, raspberries, and limes. And finally there are numerous borderline cases, possessing few of the attributes of the prototypical fruit and quite likely to be considered by some people to belong to a different category entirely, like vegetables. Such examples are coconut, avocado, and tomato.

It is important to contrast Rosch's concept of how category membership can be determined, by degree of similarity to a prototype, with more traditional theories of word meaning in linguistics and philosophy, such as those advanced by Carnap or Katz and Fodor. In such theories, the intension or meaning of a given term is believed to be a list of the analytic properties, or criterial features, which will uniquely determine what is or is not included in the extension of that term. If one of the necessary features of fruit, for example, is sweet taste, then nothing which is not sweet, such as an avocado, can ever be correctly labelled "fruit" because it violates one of the criteria of the category. The boundaries of the traditionally defined category "fruit" are not fuzzy. (For a more detailed discussion of the "old" versus "new" paradigms of reference, see Brown (1978).)

Rosch's work is potentially of great interest to developmental psycholinguists concerned with how children come to understand and use appropriately the lexical items of the language they are acquiring, especially referential terms. Based on her proposals about the structure of semantic categories, we can hypothesize about the process which the child might undergo in acquiring the meaning of a word.

One obvious hypothesis is that when a child, or an adult, for that matter, learns the meaning of a new word, he is learning the characteristics of its prototype or prototypes. In other words, he is learning to recognize the most common attributes of category members. In defining a word for someone, we tell him some or all of those characteristic attributes and, based on this information, he can then use the word appropriately in most circumstances. When the child, and particularly the very young child, is acquiring language, however, we seldom explicitly define words for him. A child is expected to learn the meaning of a referential term by noting the association of a name and its referent when he is exposed to such a pair. It is up to him to "recreate" the prototype by abstracting the characteristic attributes from the different referents of a term, since no one is providing him with a neat list of either properties or prototypes.

Fortunately for the child, however, very many of the categories of objects which he comes into contact with in the real world appear to be structured around significantly correlated sets of attributes. His task of learning the meaning of "bird", for example, should be considerably simplified because of the fact of nature that feathers and wings do occur together more often than fur and wings. If several of the relevant attributes of a category tend to appear together, they should become more salient to the child, and I think we are justified in postulating that these will be the features which he will come to associate with the category first and most reliably. It follows from this, then, that those category members which exhibit the highest number of these common features, that is, the most prototypical members, should be the ones which the child learns to identify first as members of that category.

Care should be taken here to avoid confusing claims about learning simply to identify an object and learning to identify an object as a member of some more general category. In the first case, we would expect there to be no prototypicality effect because category membership is not at issue. There is no claim that a child will learn to name, or to recognize the name "car" before the name "tricycle" just because a car is more prototypical of the category "vehicle" than is a tricycle. There is a claim, however, that he will learn to call a car, which is a highly prototypical vehicle, "vehicle" before he will learn to apply that word to a tricycle, which is much less central to the category. Indeed, the preference to apply the term "vehicle" to cars continues into adulthood.

The hypothesis underlying the research I am reporting here is this: children in general should learn to recognize and to name highly prototypical members of a given category as members of that category before less prototypical members. This hypothesis seems implicit in Rosch's work, but she has not specifically explored the developmental role of category-internal organization around a prototype in her own research. (For relevant research at the basic object level, see Bernstein (1978).) While Rosch, Mervis, Gray, Johnson, and Boyes-Braem (1976) report that children as young as four years old are highly successful in sorting objects into such superordinate categories as animals or vehicles, they don't discuss at all the possible role that prototypicality might be playing in their results. For some of the categories they use, prototypicality seems to have been controlled for, perhaps intuitively, since only relatively high prototypicality exemplars of those categories appear as stimuli, as can be seen in Table I. For other categories, however, prototypicality is either potentially irrelevant, as with people's faces, or apparently uncontrolled for. For example, the exemplars of the category "animal" are cats, dogs, butterflies, and fish. Although actual prototypicality ratings are not available for this category in the norms compiled by Rosch, one intuitively feels that butterflies and fish are somehow less central to the common notion of "animal" than are cats and dogs and one wonders if children's behavior in classifying might not reflect this

intuition.

TABLE I

Prototypicality ratings of exemplars used in Experiments 8 and 9 as reported in Rosch, Mervis, Gray, Johnson, and Boyes-Braem (1976)

Clothing		Furniture		Vehicles	
shirt	2.5	chair	1.5	car	4
socks	16	table	3.5	motorcycle	9
pants	1	dresser	6.5	train	14
shoe	27	bed	13	airplane	18
Category Mean	11.63		6.13		11.25

(All prototypicality ratings are taken from norms compiled by Rosch (1975).)

To test the hypothesis that children at the earliest stages of learning about the membership of a given category first come to identify its highly prototypical members and that only later, with increased experience, will they recognize the more peripheral members as well, I conducted two experiments. In each the prototypicality ratings of stimulus materials were systematically varied according to prototypicality norms compiled by Rosch and given in her article "Cognitive Representations of Semantic Categories". High prototypicality examples were selected from the top 30% of the norms; low prototypicality examples from the bottom 40%. Subjects were asked to identify members of particular categories in two different experimental paradigms, to be described below. Several specific predictions followed from the general hypothesis:

1) Younger children will recognize as category members a greater percentage of highly prototypical members than less prototypical members.

2) There should be a decrease with increasing subject age in the difference of percentages of high members and of low members identified as belonging to the superordinate category, since presumably older subjects will have become more familiar with less prototypical instances.

3) The absolute percentage of correct identifications of category members should increase with age for both high and low instances.

Figure II sketches the kind of developmental curve we might expect if these predictions are borne out.

Experiment I consisted of an oddity task where subjects were presented color photographs of three objects and were

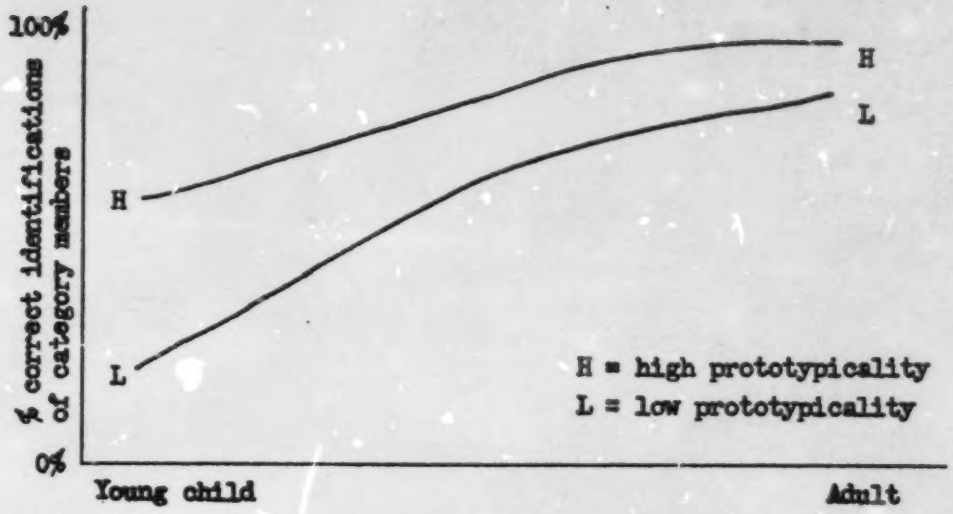


FIGURE II
Predictions for development of category-internal structure

asked to indicate which two of the three objects pictured belonged to the superordinate category named, either fruit or furniture. For each category, four highly prototypical and four more peripheral category members were selected, according to Rosch's norms, as well as six objects which were not category members. Objects were chosen whose appearance and names were expected to be familiar even to fairly young children. These stimulus objects and their prototypicality ratings are listed in Table II. Table III shows the composition of the stimulus triads for each superordinate category, where H means high prototypicality, L means low prototypicality, and X means non-member of the category. There were eighteen triads per category, thirty-six total.

The subject population consisted of eighteen 3-year olds and twenty 4-year olds, all from a university nursery school, twenty 5-year olds from a public kindergarten, and twenty adults, aged 21 to over 60, most with at least a college education. All subjects were believed to be middle or upper-middle class.

Each subject saw nine of the eighteen fruit triads and nine of the eighteen furniture triads, selected at random and shown in random order. For each triad of pictures, the subject was instructed to "show me which two things are _____" and he was told the appropriate category name. His response was then recorded. Notice that, as Table III indicates, for some triads, specifically those containing two highs and a low or two lows and a high, any response was potentially correct because all three of the objects offered were conceivably category members.

TABLE II
Exemplars used in Experiment I
and their prototypicality ratings

	Furniture		Fruit	
HIGH (H)	chair	1.5	apple	2.0
	table	3.5	banana	3.0
	dresser	6.5	grapes	9.0
	bed	13.0	grapefruit	12.0
Mean		6.13		6.5
LOW (L)	mirror	41.0	raisin	39.0
	rug	45.0	coconut	43.0
	wastebasket	47.0	avocado	44.0
	clock	52.0	tomato	46.0
Mean		46.25		43.0
NON-MEMBERS (X)	toilet		Christmas ornament	
	ladder		wooden stick	
	box		Lincoln Log	
	2-block form		marbles	
	3-block form		softball	
	sleeping bag		plastic sphere	

TABLE III
Composition of triads per superordinate category
in Experiment I

number	type	correct categorical selection(s)	
3	H_1H_2X	H_1H_2	$H_1 \neq H_2$
3	L_1L_2X	L_1L_2	$L_1 \neq L_2$
6	HLX	HL	
3	H_1H_2L	H_1H_2 or H_1L or H_2L	
3	HL_1L_2	HL_1 or HL_2 or L_1L_2	
18			

If the subject's initial response for these triads was that all objects were fruit or furniture, he was encouraged to indicate which two things were the "best" fruit or the "best" furniture, with the interpretation of "best" left unspecified. Presumably the subject's interpretation might be "the best examples" or "the ones I like best" or something else. The "all" comment plus the prompted response was recorded.

In Experiment II, subjects were presented with three arrays of actual objects, one array at a time, where each group of objects was composed of four highly prototypical members of a

superordinate category, four low prototypicality members, and four non-members. Table IV shows these objects and their prototypicality ratings. The objects within one array were identified by name and laid out before the subject in random order and he was then asked to place all objects which were members of the category named (fruit, (toy) furniture, or clothing) in a large basket. The objects he chose and the order of their selection was recorded for each subject. For this experiment, the subjects were ten 3-year olds and ten 4-year olds, contacted through the Stanford nursery school, and ten 5-year olds from a public kindergarten class.

TABLE IV
Stimulus items for Experiment II
and their prototypicality ratings

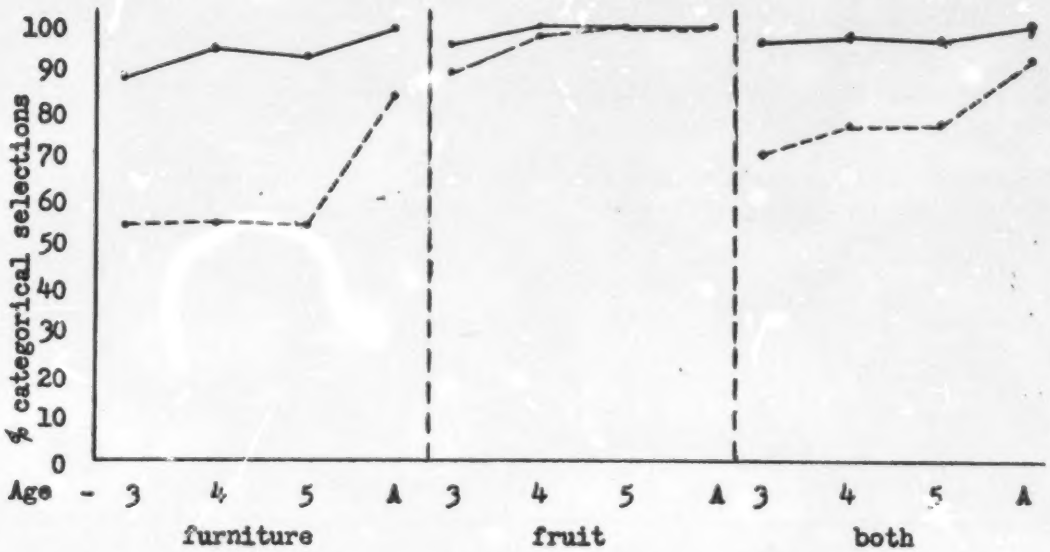
	Furniture		Fruit		Clothing	
HIGH	chair	1.5	orange	1.0	pants	1.0
	table	3.5	apple	2.0	shirt	2.5
	dresser	6.5	banana	3.0	dress	2.5
	bed	13.0	pear	5.0	socks	16.0
Mean		6.13		2.75		5.5
LOW	mirror	41.0	raisins	39.0	scarf	38.0
	television	42.0	coconut	43.0	slippers	40.0
	pillow	46.0	avocado	44.0	hat	41.0
	clock	52.0	tomato	46.0	purse	47.0
Mean		45.25		43.0		41.5
NON-MEMBERS						
	dustpan		ball		goggles	
	broom		toy football		bib	
	tea kettle		radish		camera	
	plastic box		cottage cheese carton		guitar	

The results of these two experiments are graphed in Figures III through V. On each graph, the abscissa shows increasing age from left to right and the ordinate indicates the percentage of correct identifications of stimuli as category members from the total number of opportunities offered for identification. The solid lines represent highly prototypical category members and the broken lines, low prototypicality members. Data from different superordinate categories have been displayed separately, as well as the categories combined. The results of Experiment I have been further broken down into Figure III, which represents the triads containing two category members and one non-member, and Figure IV, representing triads composed only of category members of different prototypicality ratings.

If we compare Figure III with the predictions of development

in Figure II it looks like we have good empirical support for our hypothesis about prototypicality as a factor in the development of cognitive categories. The youngest subjects correctly selected a significantly higher percentage of high prototypicality exemplars as category members than they did low prototypicality examples (except for "fruit", where the difference was not significant). Correct identifications of both high and low members increased with age and there was a decrease in the difference of correct identifications of high and low members in the older subjects. In fact, for the superordinate category "fruit", both high and low members were correctly identified one hundred percent of the time by the time subjects were five years old.

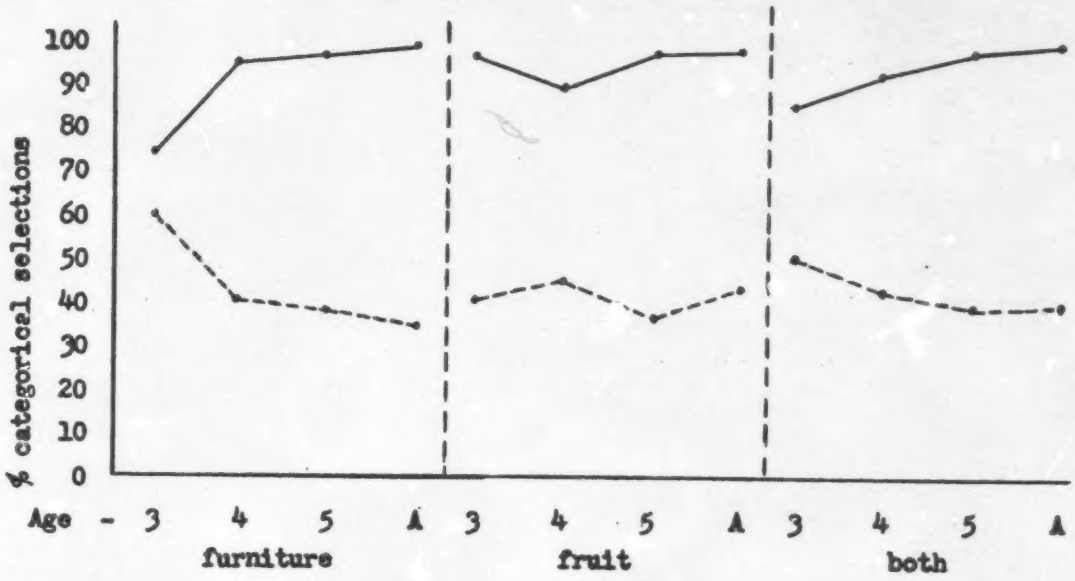
FIGURE III
Correct categorical selections in Experiment I
(HHX, HLX, LLX triads only)



The data in Figure IV are less supportive at first glance. Although awareness of the category membership of highly prototypical members generally does appear to develop as predicted, older subjects seem to be less and less willing to select low prototypicality examples as category members. This initially disturbing result can be understood, however, if we realize, first of all, that the percentage of correct identifications of high and low prototypicality category members does not vary independently in this task; selecting an H member means not selecting an L member and vice versa. This was not true for triads containing only two category members. The second factor involved is the high preference by subjects of all ages for selecting highly prototypical members to represent the category over less prototypical members, where either choice is potentially

correct. Thus, despite evidence from the same experiment that older subjects are increasingly aware of the category membership of low prototypicality exemplars, the actual proportion of such items selected is low for HHL and HLL triads.

FIGURE IV
Correct categorical selections in Experiment I
(HHL, HLL triads only)



The preference to choose the best examples of a category is completely in line with Rosch's experimental findings; indeed, we should be somewhat surprised to see the drop in correct identifications of high prototypicality fruit by four-year olds in Figure IV. Two possible explanations come to mind for this:

1) First, it could be that as these children are becoming increasingly aware of the expanding membership of the category "fruit", the internal organization of the category is being "shaken up" and they are a little less than sure of the applicability of the "choose-the-best-example" principle, which seems to be operating in older children and adults. Since the four-year olds are learning that less prototypical examples <u>can</u> be category members, they are sometimes selecting them to represent the category instead of more central examples, but by age five, the preference for best examples apparently is firmly established.

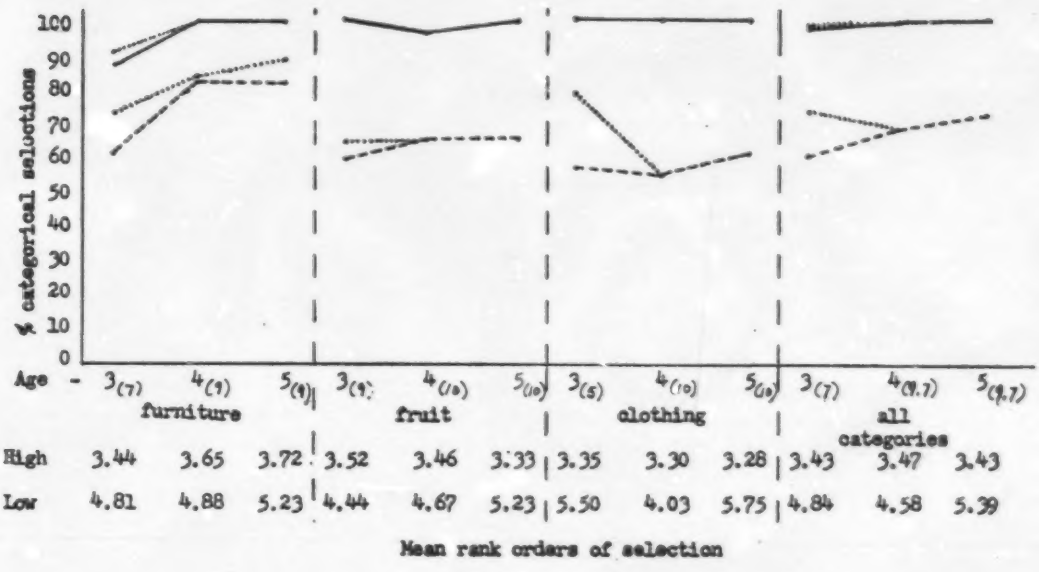
2) A second possible explanation lies in the fact that in more than 27% of the instances where a four-year old was presented one of these triads containing three possible fruits, he spontaneously commented that they were all fruit. He was then prompted to select the "best" fruit, as described earlier. The drop in selections of highly prototypical fruit could well be reflecting cases where children have chosen two fruits according to

personal preference or some principle other than high prototypicality.

Both of these explanations are worth pursuing in further work; it would be especially interesting to look for further evidence of a period of "organizational instability" within a category. As should be clear from comparing the data from "fruit" versus "furniture", categorical development, at least as tapped by this task, does not proceed at the same rate across all categories nor are adults in agreement about the more peripheral category members to the same degree for all categories. If an "unstable" period exists, it may well fall at different ages for different superordinates and it will probably be worthwhile doing further research with a wider age-range of subjects.

Figure V shows the results from Experiment II. The dotted lines represent data from all thirty subjects. There were, however, a number of the 3-year olds, one 4-year old, and one 5-year old who seemed to interpret the task inappropriately for one or more categories by putting all twelve objects into the basket, including the non-members of the category. When we eliminate the data from these subjects who selected all objects indiscriminately, we see results as represented by the solid and broken lines on Figure V. The numbers in parentheses below the subject ages indicate the number of subjects for whom data is graphed in this way. Once again, we see that category development is generally in the predicted direction, although ultimate development is uncertain since there are no data from adults. The two slight downward slopes on Figure V are not statistically significant.

FIGURE V
Correct categorical selections in Experiment II



Although there was no a priori theoretical reason to expect it to be the case, there was also a slight but consistent ordering effect for Experiment II, such that the mean rank order of selection of the highly prototypical members of each category was higher than that of the less prototypical members. These mean rank orders are given at the bottom of Figure V. They may well reflect the general strategy, at least on the part of some children, to identify first the category members they are most sure about, usually the more prototypical ones, and then to include less central items.

Having found evidence that prototypicality may well play a role in the course of development of some conceptual categories, what might this mean to those of us interested in semantic development? Obviously, we want to better understand the relationship between cognitive and linguistic development in children, but are we justified in jumping to the conclusion that prototypicality will also be a factor as the child learns to map the correct names onto his developing conceptual categories? The two experimental tasks given to my subjects required them to demonstrate some understanding of category labels, and their comprehension behavior seems to reflect a developing category-internal organization around prototypical members. As yet, however, we have no indication that prototypicality is involved when children begin to produce category names themselves, and it will require further observation and different elicitation techniques to provide evidence supporting or disconfirming the role of prototypicality in children's language production.

Finally, it will be crucial for us to look at the possible influence of prototypicality in adult naming behavior to children if we are to understand more clearly the linguistic importance of Rosch's notion of category structure. Do adults consistently select only highly prototypical members as referents when they are introducing category labels to young children? Do they include more peripheral category members as the child grows older? How much and when does the child begin including as category members low prototypicality items which have not been specifically identified for him by their category labels? When do adults qualify the category membership of less central members with expressions like: "It's a funny kind of a ...." or "It's a sort of a ...." in speaking to children? I hope to look into such questions in further research; hopefully their answers will give further insights into how children come to understand and to use referential terms.

*ACKNOWLEDGEMENTS

An earlier version of this paper was presented at the Boston University Conference on Child Language Development, September 1977. I would like to thank several people for their help: Professor Roger Brown for first introducing me to the "new" paradigm of reference; Professor Eve Clark and Dr. Lise Menn for many valuable comments on earlier versions of this paper; and Dr. Robin Ault for helping to untangle the statistics.

Also I would like to thank the staff of Bing Nursery School and Mrs. Nancy Auker of the San Leandro Public Schools for providing me access to the children. This research was supported by a Graduate Fellowship from the National Science Foundation.

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